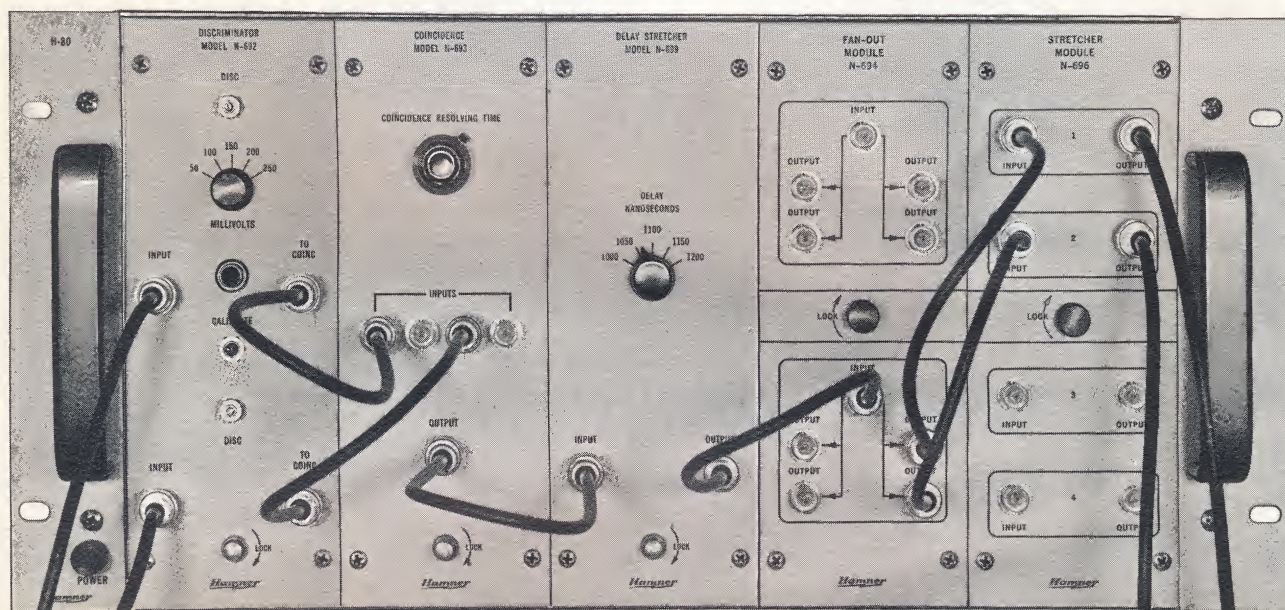


Hamner

HAMNER ELECTRONICS CO., INC.
A Subsidiary of The Harshaw Chemical Company

Technical Bulletin

100 MCPS



HAMNER "FAST-FAST" 100 MCPS LOGIC SERIES

APPLICATION

The Hamner "FAST-FAST"* series of instruments is designed for high resolution data retrieval in particle experimental physics, telemetry and other data handling applications requiring high speed, unit-to-unit compatibility, "black-box" logic flexibility of modular construction and maximum reliability. This system will process asynchronous digital pulse data at 100 Mcps and will permit coincidence resolving times limited only by photomultiplier tube time jitter.

*In the context of this data sheet the term "FAST-FAST" Coincidence refers to $2t$ resolving times in the 1 to 10 nanoseconds range and "Fast Coincidence" refers to $2t$ resolving times in the 10 to 30 nanoseconds range.

The Hamner "FAST-FAST" System is all solid-state construction throughout. Extensive use is made of gallium arsenide tunnel diodes in very reliable configurations. 50 ohm $\pm 5\%$ input-output impedances are maintained throughout. Output pulse shapes and input requirements are matched so that any logically appropriate module may be used to drive any other. Seven presently available units in this series, together with the Hamner Standard Module Series of "FAST Coincidence" components provide thirty or more separate logic and data processing functions, including:

- FAST coincidence ($2t = 10$ to 30 nanoseconds)
- FAST-FAST coincidence ($2t = 1$ to 10 nanoseconds)
- FAST anti-coincidence (gatewidth = 10 nanoseconds)
- Low jitter pulse height discrimination
- Pulse shaping and standardizing
- Active circuitry fully isolated fan-out
- Fan-in • Pulse stretching and scaler driving
- Fast scaling • Logic and/or gating • Pulse generation
- RC clipped and double delay line clipped linear pulse amplification

TYPICAL SYSTEM PERFORMANCE

In coincidence applications the Hamner FAST-FAST System may be used by itself to process two-parameter coincidence information (total pulses and numbers of coincidences). Or it may be employed in conjunction with the Hamner FAST System to provide three-parameter coincidence information (total pulses, differential energy spectrometry and numbers of coincidences). Gross doubles coincidences of 2t resolving times in the 1-10 nanosecond range can be processed at the 100 Mcps FAST-FAST System speed. In the three-parameter coincidence system, 2t coincidence resolving times are also in the 1-10 nanosecond range, but the data are processed at 1 Mcps, as limited by the capability of the Hamner NC-14 Low Jitter

Pulse Height Analyzer. Block System diagrams of typical "FAST-FAST" gross coincidence and spectrometry coincidence systems are shown in Figure 1.

The system performance of the FAST-FAST configuration is particularly dependent upon the quality of the high-gain photomultiplier head assembly. The Hamner N-390 High Gain 100 Mc. Phototube Head and Preamplifier has been specifically designed to drive this FAST-FAST System. Cable curves are shown in Figures 2 and 3 with this head under several sets of conditions. Figure 4 indicates the coincidence resolving times that can be attained with the various detector phosphors.

GENERAL FEATURES

Reliability: All circuit configurations of the FAST-FAST Coincidence System have been subject to severe "worst-case" studies, whereby each circuit block is tested with various combinations of low beta, high beta, leaky and noisy transistors over a temperature range of 0°C to 50°C. Other component values and the circuit configurations are then optimized to allow specifications to be met of the broadest possible range of transistor parameters. Reliable operation is thus assured over a wide range of environmental and component parameter conditions.

Stability: Module stabilities are 0.1 nanosecond/24 hours or better and 0.1 mv/°C or better. "Walk" or time slew is 1 nanosecond or less for pulse height changes from discriminator threshold setting to ten times the discriminator level, with appropriately shaped pulses. Drift as functions of changes in temperature, component aging, operating voltages, pulse height and input

rate have all been optimized to the best practice of the state of the art.

Accuracy: All circuitry has been vigorously designed to minimize the introduction of perturbations extraneous to the data being processed. Reliable statistics are thereby assured which virtually eliminates the need for recalibration.

Uniformity: The interchange of one module for another will have no effect upon system performance or experimental statistics.

Ease of Use: All Hamner FAST-FAST modules are functionally straightforward, easy to operate and designed to interconnect easily into complex logic configurations. All signal input and output connectors are front panel mounted. Important bias adjustments and test points have been made conveniently available.

COINCIDENCE AND SPECTROMETRY CONFIGURATIONS

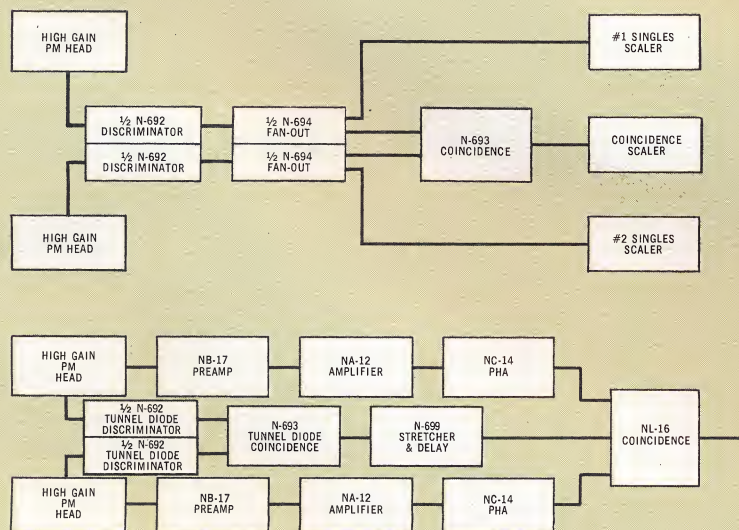


FIGURE 1

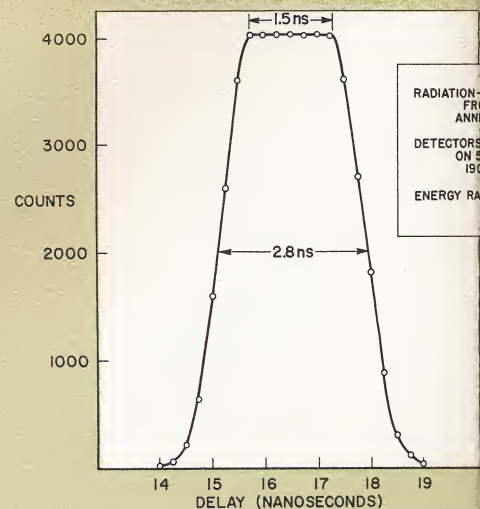


FIGURE 2



N-390 HIGH GAIN 100 Mc. PHOTOTUBE HEAD AND PREAMPLIFIER

The N-390 is specifically designed to drive fast $2t = 1$ to 10 nanosecond coincidence and discriminator circuitry. In this application it must be used with high-gain photomultiplier tubes of the Phillips 56AVP or 58AVP type viewing plastic phosphors. NaI detectors may be used for slightly slower coincidences in the $2t = 2$ to 10 range.

The N-390 circuit incorporates a Simms preamplifier section followed by a Chase circuit for linear output from the 7th dynode. The top five dynodes are provided with individual transistor voltage regulators, thus providing excellent gain stability under high count rate conditions. This unit is mounted in a heavy cylindrical aluminum case into which is wired a 20-pin phototube socket. No separate preamplifier power is required. The "Preamp" output is fed directly from the 7th dynode by way of a unity gain isolation circuit.

SPECIFICATIONS

Outputs: Three are provided: "FAST," "Nal" and "Preamp."

Connectors, All Outputs: BNC-UG290/U.

"Fast" Output

Polarity: Negative.

Impedance: 50Ω .

Risetime: 1 to 5 nanoseconds.

Function: Drives N-692 Dual High Speed Discriminator when plastic phosphor/56AVP type high gain phototube detector assemblies are employed.

"Nal" Output

Polarity: Negative.

Impedance: 50Ω .

Risetime: 5 to 10 nanoseconds.

Function: Drives N-692 Dual High Speed Discriminator when NaI detectors are used.

"Preamp" Output

Polarity: Negative.

Impedance: 50Ω .

Risetime: 5 to 10 nanoseconds.

Function: Drives Hamner FAST coincidence System through NB-17 Preamplifier. In FAST-FAST spectrometry-coincidence systems, this output drives the FAST spectrometry portion of the system, while the "FAST" output drives the 100 Mc FAST-FAST portion of the system.

High Voltage Requirement: 1.6 Kv to 2.2 Kv at 6 Ma.

High Voltage "ON" Warning: By means of red light or preamplifier body.

Maximum High Voltage: 2.5 Kv.

Power: None required other than High Voltage.

TYPICAL CABLE CURVES

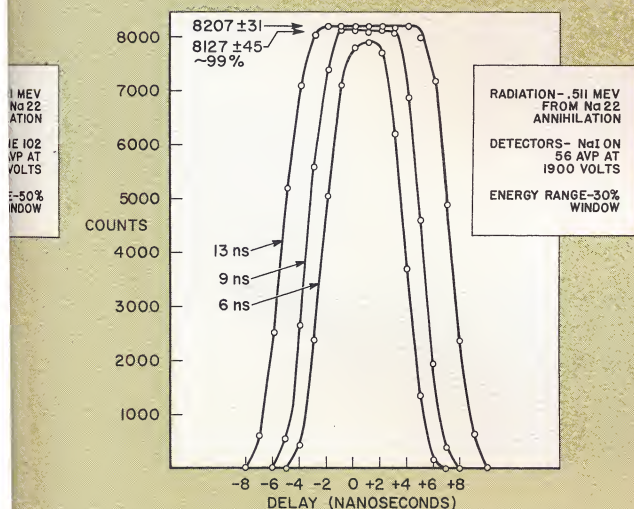


FIGURE 3

COINCIDENCE RESOLVING TIMES

DETECTOR	Fast System	Fast-Fast System
Plastic Phosphor	10-25 ns	1-5 ns
Sodium Iodide (20% Window)	20-40 ns	2-10 ns (greatly dependent upon energy)
Sodium Iodide (Wide Window)	35-50 ns	4-15 ns (greatly dependent upon energy)

FIGURE 4

N-692 DUAL HIGH SPEED DISCRIMINATOR MODULE

The N-692 consists of two identical, isolated variable threshold discriminators. This module accepts signals directly from the dynode ("FAST") output of the N-390 High Gain Phototube Head and presents an output pulse that is constant in time and shape for each input pulse which exceeds the adjustable threshold level. These shaped output pulses are then suitable for timing purposes. Five selectable calibrated discriminator thresholds are provided. Each section of the N-692 will accept, discriminate and shape 100 megacycles of asynchronous pulses per second. Maximum time shift with pulse height (slewing or walk) is 1 nanoseconds or better from threshold level to 10X threshold.

SPECIFICATIONS (Each section of two-section module)

Input Data

Number of Inputs: One.

Sensitivity: -50, -100, -150, -200 or -250 millivolts. Adjustable by front panel switch.

Impedance: 50Ω.

Polarity: Normally negative. Positive polarity optional.

Risetime Requirement: 1 to 5 nanoseconds.

Pulse Width Requirement: 40 nanoseconds or less. Shorter clips required for ultra-high counting rates.

Overload Characteristics: Pulses as large as -20 volts will not cause double pulsing on the output or change the input impedance from 50Ω.

Reflection: ±10% maximum.

Pulse Pair Resolution: 10 nanoseconds or 100 nanoseconds, optionally.

Output Data

Outputs: One.

Amplitude: +300 millivolts.

Width: 4 nanoseconds full width at half maximum height. Other widths available optionally.

Risetime: 1 nanosecond.

Impedance: 50Ω.

Stability

Temperature: 0.1 mv/°C or better.

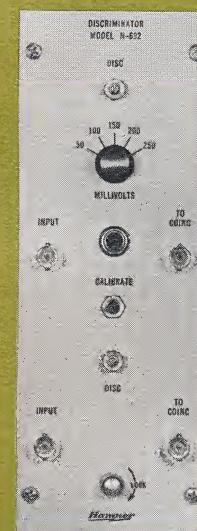
Long Term: 0.1 nanoseconds/24 hours or better.

Walk: 1 nanosecond or less for pulse height changes from discriminator threshold to 10X discriminator level, with input pulse risetime of 0.2 nanoseconds.

Discriminator Set: Allows discriminator set point to be calibrated to fixed bias levels of -50, -100, -150, -200 and -250 millivolts.

Discriminator Test Lamp: Lights when discriminator level equals test bias level.

Connectors, Inputs and Outputs: BNC-UG290/U.



N-693 TUNNEL DIODE COINCIDENCE MODULE

The N-693 Coincidence Module will accept up to four inputs for coincidence. This module will process coincidence information in the $2t = 1$ to 10 nanosecond range at counting rates of 100 Mcps. A ten-turn front panel helipot provides selectable $2t$ coincidence resolving times of 1 to 10 nanoseconds when pulses shaped by the N-692 Dual Discriminator are used as the input source. This helipot also permits the selective counting of singles, doubles, triples or quadruples. The N-693 will record coincidences with 10 nanosecond pulse pair resolution, and will process pairs of singles as close together as 10 nanoseconds without ambiguity. Output pulse is restandardized to FAST-FAST System Level.

SPECIFICATIONS

Input Data

Number of Inputs: Four.

Sensitivity: +250 millivolts nominal into 50Ω.

Width and Risetime Requirements: As shaped by N-692 Dual Discriminator to FAST-FAST standardization. No substandard pulses permitted for optimum performance.

Coincidence Resolving Time: $2t = 1$ nanosecond. Controlled by ten-turn helipot.

Singles Feedthrough: 50 millivolts or less.

Output Data

Number of Outputs: One.

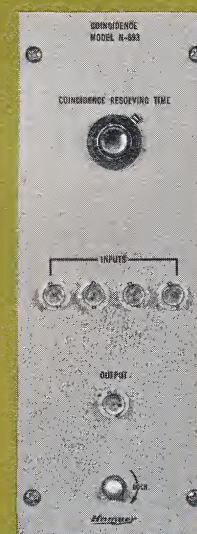
Amplitude: +300 millivolts into 50Ω.

Width: 4 nanoseconds full width at half maximum height.

Risetime: 1 nanosecond.

Resolving Time Stability: 0.1 nanoseconds/24 hours (20°C to 40°C).

Connectors, Input and Output: BNC-UG290/U.



N-694 DUAL FOUR-FOLD FANOUT

The N-694 will accept a single pulse standardized to FAST-FAST conditions and will present four outputs of amplitude and shape equal to the input pulse, each suitable for driving 50Ω. Each module contains two such independent four-fold fanouts. The N-694 employs active circuitry throughout with complete isolation between all outputs. Amplification to unity and restandardization permits N-694 modules to be cascaded to provide any number of channels of pulses identical to those of the input. Each of the dual fanouts may also be used to provide two independently clipped outputs, two back-terminated outputs, two double amplitude outputs or any combination thereof. Pulse pair resolution is 10 nanoseconds or better for standardized pulse inputs.

SPECIFICATIONS (Each section of two-section module)

Input Data

Number of Inputs: One.

Input Range: -250 millivolts to 1 volt into 50Ω.

Reflection: ±10% maximum.

Width and Risettime Requirements: As shaped to FAST-FAST standardization.

Output Data

Number of Outputs: Four.

Output Level: -300 millivolts in 50Ω.

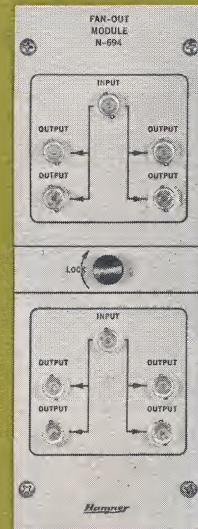
Output Risettime: 1 nanosecond.

Output Pulse Width: Identical to input pulse unless clipped.

Clipping: Each pair of outputs may be clipped with shorted 93Ω cable.

Stability: 0.1% output amplitude change/°C or better from 20° to 40°C.

Connectors, Inputs and Outputs:
BNC-UG290/U.



N-695 DUAL FOUR-FOLD FAN-IN

The N-695 contains two four-fold fan-in sections. Each input is completely isolated from all others. Each section will "mix" four 50Ω input channels and present a standardized output pulse whenever a pulse is present on any of the inputs. Pulse pair resolution is 7 nanoseconds or better. Input pulses can be processed at 100 Mcps per section. This module incorporates noise rejection threshold, and four simultaneous inputs or less than 80 millivolts will not cause any output.

SPECIFICATIONS (Each section of four-section module)

Input Data

Number of Inputs: Four.

Input Range: -250 millivolts to -400 millivolts into 50Ω.

Reflection: ±10% maximum.

Pulse Pair Resolution: 7 nanoseconds or better.

Width and Risettime Requirement: As shaped to FAST-FAST standardization.

Output Data

Number of Outputs: One.

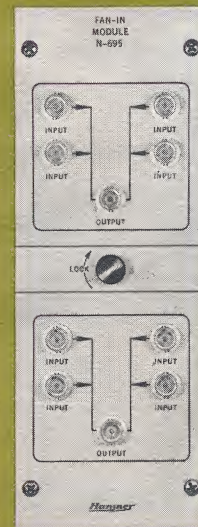
Amplitude: -300 millivolts into 50Ω.

Width: 4 nanoseconds full width at half maximum height.

Risettime: 1 nanosecond.

Noise Rejection: Four simultaneous input pulses at 80 millivolts amplitude or less will not cause any output pulse.

Connectors, All Inputs and Outputs:
BNC-UG290/U.



N-696 FOUR CHANNEL SCALER DRIVER

The N-696 is an interface module which will accept FAST-FAST standardized pulses and present stretched and amplified output pulses suitable for driving scalars and other large-amplitude, slow logic systems such as spark chambers, computers and pulse integrators. This module contains four such completely isolated dynamic channels. The unit will operate to 20 Mcps. False output due to noise or reflections is inhibited by a 700 millivolt output threshold. Output pulses are standardized to slow circuitry requirements.

SPECIFICATIONS (Each section of four-section module)

Input Data

Number of Inputs: One.

Input Range: -250 millivolts to 2 volts.

Width and Risettime Requirements: As shaped to FAST-FAST standardization.

Reflection: ±10% maximum.

Output Data

Number of Outputs: One.

Amplitude: 10 volts into 50Ω.

Polarity: Positive.

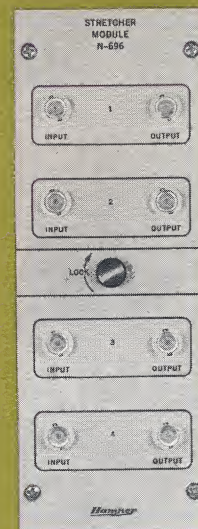
Pulse Width: 10 to 200 nanoseconds, variable by changing inductor.

Risettime: 10 nanoseconds nominal.

Pulse Pair Resolution: 10 nanoseconds.

Maximum Continuous Count Rate: 20 Mcps.

Connectors, All Inputs and Outputs:
BNC-UG290/U.



N-699 DELAY STRETCHER AND SCALER DRIVER

The N-699 is an interface module used to connect the Hamner FAST-FAST system to the FAST system in applications requiring high speed spectrometry coincidence determinations. The use of this module in such a system is shown in the system block diagram in Figure 2. This module will accept standardized pulses from the N-693 Coincidence unit, and stretch, delay and amplify them to a form suitable for driving the LC-14 Low Jitter Pulse Height Analyzer. Selectable pulse delays of 1000, 1050, 1100, 1150 or 1200 nanoseconds may be chosen by switch for the purpose of matching FAST-FAST System propagation times to those of the FAST System.

SPECIFICATIONS

Input Data

Number of Inputs: One.

Sensitivity: ~ 250 millivolts into 50 Ω .

Risetime and Pulse Width Requirements: As shaped to Hamner FAST-FAST standardization. This module may be driven by the N-692, N-693, N-694 and N-695.

Reflection: $\pm 10\%$ maximum.

Pulse Pair Resolution: 10 nanoseconds.

Output Data

Number of Outputs: One.

Amplitude: 6 volts maximum into 50 Ω .

Polarity: Positive.

Pulse Width: > 200 nanoseconds.

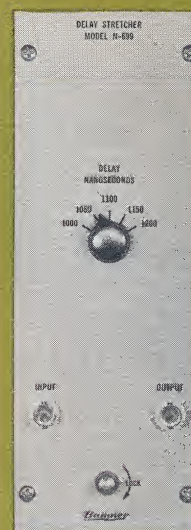
Risetime and Falltime: 15 nanoseconds, nominal.

Pulse Pair Resolution: 0.5 μ sec.

Maximum Continuous Count Rate: 20 Mcps.

Output Delays: 1000, 1050, 1100, 1150 and 1200 selectable on front panel switch.

Connectors, All Inputs and Outputs: BNC-UG290/U.



H-80 BIN AND POWER SUPPLY

The H-80 will house up to 5 individual single modules. Any module may be plugged into any vacant space in the H-80. The base unit incorporates a high quality power supply suitable for almost any present or future requirement. The connectors through which the base unit is connected to an individual module provide only power. All signal connections are made via the front panel for ease in setting up systems. Construction of the base unit also allows rear connectors to be used on individual modules when desirable.

Both the base unit and individual modules have been designed to highest mechanical standards for perfect alignment. Guided blue ribbon connectors are used to transmit power, and the units are held in place by a center locking device.

This base unit may be rack mounted in existing form or may be used on the bench. A black vinyl covered sheet metal cover is also available to make an attractive bench mounted unit.

SPECIFICATIONS

Power Supply Outputs:

#1 $\rightarrow +6V$ at 1.5A.

#2 $\rightarrow +6V$ at 1.5A.

#3 $\rightarrow +32V$ at 0.5A.

Regulation: All outputs are regulated to 2 Mv. for 105 to 125V line change

and to 2 millivolts, zero to full load.

Temperature Stability: Better than ± 2 Mv./ $^{\circ}C$.

Power Requirements: 110V, 60 cycle, 100W or 220V, 50 cycle, 100W.

ACCESSORIES

50 Ohm Termination

This termination consists of a BNC connector with a 50 ohm $\pm 5\%$ resistor permanently terminating it.

50 Ohm Matching Tee

This tee will accept a single pulse input, terminating it in 50 ohms and will present two outputs, each with $\frac{1}{2}$ the input amplitude and each reverse terminating in 50 ohms.

Pulse Inverting Transformer

This transformer will accept nanosecond pulses at its input and will present them with inverted polarity at its output. Risetime is about 1 ns. Droop is about 3% for 250 ns wide pulses. Both input and output con-

nectors are BNC signal type. Input and output impedances are 50 ohms.

Calibrated Delay Lines

These lines are calibrated lengths of RG 223/U double shielded 50 ohm line with BNC connectors on both ends. Standard lengths are 1, 2, 4, 8, 16 and 32 ns. Accuracies are ± 0.1 ns for longer lines.

Signal Interconnecting Cables

Double shield 50 ohm coaxial cables with BNC K-grip male connectors are available for system logic programming and module inter-connection in the following standard lengths:

6 inches
12 inches
18 inches
36 inches



HAMNER ELECTRONICS CO., INC.

A Subsidiary of The Harshaw Chemical Company

P. O. BOX 531, PRINCETON, N. J. 08540 • PHONE: 609-737-3400

Company Sales Offices in New York, Boston, Washington, D. C., Chicago, San Francisco, and Representatives in the following cities: Detroit (B. Z. Rubin Co.) • Denver, Salt Lake City, Albuquerque, Phoenix (Hytronics Inc.) • Seattle, Idaho Falls (Showalter-Judd) Orlando, Knoxville, Winston-Salem (COL-INS-CO. INC.) • Dallas, Houston, (Scientific Sales Co.) • Foreign (Henley & Co., New York)



HAMNER ELECTRONICS CO., INC.

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PRICE LIST • JANUARY 27, 1965

NEW STANDARD MODULE SERIES

Bin and Power Supply:

*(12) NH-84 Standard Bin and Power Supply.....\$ 695.00

Amplifiers:

*(1) NA-11 Double RC Clipped Linear Amplifier Module..... 285.00
*(1) NA-12 Double Delay Line Linear Amplifier Module..... 525.00
*(1) NA-12-D Double Delay Line Linear Amplifier with delayed output..... 595.00
*(2) NA-15 RC Amplifier-Discriminator Module..... 350.00

Preamplifiers: (all prices less detector assembly)

NB-11 Preamplifier..... 150.00
NB-12 Preamplifier and Detector Base..... 225.00
NB-14 Proportional Counter Preamplifier..... 165.00
NB-15 Probe with Preamplifier..... 240.00
~~NA~~-17 Nanosecond Linear Preamplifier..... 195.00
N-390 High Gain 100 Mc. Preamplifier and Detector Base..... 465.00

Discriminators and Pulse Height Analyzers:

*(1) NC-10 Integral Discriminator..... 165.00
*(1) NC-11 Single Channel Pulse Height Analyzer..... 425.00
*(2) NC-14 Low Jitter Pulse Height Analyzer..... 650.00

Coincidence and Logic Modules:

*(2) NL-16 Fast Ramp Coincidence Module..... 495.00
*(2) NL-30 Nanosecond Switchable Delay..... 225.00

Scalers:

*(2) NS-10 Electromechanical Preset Count Scaler..... 450.00
*(4) NS-11-1 Six Decade Printing Scaler - 1 Mc..... 695.00
*(4) NS-11-1E Six Decade Printing Preset Count Scaler - 1 Mc..... 795.00
*(4) NS-11-10 Six Decade Printing Scaler - 10 Mc..... 795.00
*(4) NS-11-10E Six Decade Printing Preset Count Scaler - 10 Mc..... 895.00
N-290-1 Six Digit Nixie Display Scaler - 1 Mc 19" Rack..... 1095.00
N-290-10 Six Digit Nixie Display Scaler - 10 Mc 19" Rack..... 1195.00

Series N-290 Options:

Option B - Seventh Decade Addition.....	- Additional.....	100.00
Option E - Preset Count Addition.....	- Additional.....	100.00
Option F - BCD Printing Output Addition -	Additional.....	100.00

Decades and Pre-Scalers:

* (1)	NJ-10 10 Mc. Decade Module.....	230.00
* (2)	NJ-15 Four-Decade Expander.....	350.00

Timers:

* (4)	NT-10 Mechanical Timer.....	130.00
* (4)	NT-11 Printing Precision Electronic Timer.....	945.00
* (2)	NT-15 Four Decade Electronic Timer/Scaler.....	475.00
* (2)	NT-15F Printing Four Decade Electronic Timer/Scaler.....	550.00
	N-820 Precision Six Decade Nixie Timer 19" Rack.....	1395.00
	N-820F Printing Precision Six Decade Nixie Timer 19" Rack.....	1495.00

Series N-820 Options:

Option B - Seventh Decade Addition.....	Additional.....	100.00
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High Voltage Supplies:

NV-13 Regulated High Voltage Supply - 2 kv 19" Rack.....	425.00
N-4035 High Voltage Power Supply 19" Rack.....	650.00
N-4050 High Voltage Power Supply 19" Rack.....	595.00

Pulsers:

* (2)	NP-10 Mercury Switch Pulser.....	225.00
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Detectors:

ND-10 Fast Integral Plastic Scintillation Detector.....	520.00
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For other detectors in the Hamner line, refer to Harshaw catalog.

Standard Bins, Blank Modules and Panels:

Quantity

	1-10	11-20	21 & Over
NQ-50 Standard Bin Without Power Supply.....	130.00	123.50	117.00
NQ-10 Standard Blank Plug-in, Single Width.....	28.25	26.84	25.42
NQ-20 Standard Blank Plug-in, Double Width.....	31.75	30.16	28.57
NQ-40 Standard Blank Plug-in, Four Width.....	36.50	34.67	32.85
Prices shown above do not include connectors. Add \$11.00 per connector to any modules or bins as required.			
NQ-50C Standard Bin Without Power Supply.....	260.00	247.00	234.00
but with 12 wired Amp. 202516-3 Female Block Connectors and Pins .			
NQ-11 Blank Front Panel, Single Width.....	8.50	8.07	7.65
NQ-21 Blank Front Panel, Double Width.....	9.50	9.02	8.55
NQ-41 Blank Front Panel, Four-Width.....	10.50	9.97	9.45

Cabinet Hardware:

NQ-0875 Instrument Cabinet, 8 3/4" Panel.....	105.00
NQ-1225 Instrument Cabinet, 12 1/4" Panel.....	110.00
NH-10 Single Module Instrument Case For N-183 or N-630.....	50.00

Circuit Boards and Components:

NX-01 100 kc. Decade Boards.....	73.50
NX-1 1 Mc. Decade Board.....	82.50
NX-10 10 Mc. Decade Board.....	180.00
NX-15 Low Voltage Power Supply (less bin).....	435.00

MODUFLEX SERIES

Bins and Power Supply:

H-80 Bin and Power Supply.....	450.00
H-82 Bin and Power Supply, Horizontal Configuration.....	400.00

"Fast-Fast" 100 Mc. Logic Series:

N-692 Dual High Speed Discriminator.....	465.00
N-693 Tunnel Diode Nanosecond Coincidence Unit.....	350.00
N-694 Dual Four-Fold Fan-Out.....	390.00
N-695 Dual Four-Fold Fan-In.....	395.00
N-696 Scaler Driver.....	395.00
N-699 Delay Stretcher and Scaler Driver.....	295.00

Ratemeters and Spectrometer Series:

N-751 Linear Count Ratemeter Module.....	370.00
N-752 Log Count Ratemeter Module.....	495.00
N-780 Precision Log-Linear Ratemeter.....	990.00
N-688 Electronic Baseline Spectrometer Sweep.....	295.00

Amplifiers:

N-340 Double RC Clipped Linear Amplifier.....	295.00
N-340A Double RC Clipped Linear Amplifier, horizontal configuration.....	295.00
N-341 RC Amplifier-Discriminator Module.....	350.00
N-341A RC Amplifier-Discriminator Module.....	350.00
N-380 Double Delay Line Linear Amplifier.....	525.00
N-380A Double Delay Line Linear Amplifier, horizontal configuration.....	525.00
N-383 Double Delay Line Linear Amplifier with Delayed output....	595.00

Preamplifiers: (all prices less detector assembly)

N-381 Preamplifier.....	150.00
N-382 Preamplifier with Wired PM Tube Socket.....	225.00
N-384 Proportional Counter Preamplifier.....	175.00
A-19 Probe with Preamplifier.....	240.00
SX-10 Scintillation Preamplifier for X-Ray.....	320.00
SX-11 Proportional Preamplifier for X-Ray.....	320.00

Discriminators and Pulse Height Analyzers:

N-685	Low Jitter Pulse Height Analyzer.....	650.00
N-686	Single Channel Analyzer.....	345.00
N-686A	Single Channel Analyzer, horizontal configuration.....	345.00
N-687	Integral Discriminator.....	155.00

Scalers:

N-295	Decade Scaler.....	795.00
	Addition of 10 Mc. Counting Capabilities to N-295.....	100.00
	Addition of Preset Count.....	130.00
	Addition of 7th Decade.....	95.00
	Addition of BCD Output.....	75.00
N-251	Seven Digit Electromechanical Scaler.....	590.00

Timers:

N-821	Mechanical Timer.....	130.00
N-825	Precision Electronic Tuning Fork Timer.....	945.00

Coincidence Modules:

N-681	Fast Ramp Coincidence Module.....	425.00
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Miscellaneous:

N-183	Mercury Switch Pulser.....	195.00
N-630	Delay Box.....	225.00
	Service Kit of Extension Cable and Plug Board Extenders.....	25.00
	50 ohm Cables with Male BNC UG290/U Connectors.....	5.00
A-80	Moduflex Blank Module.....	25.00
A-81	Moduflex Blank Panel, Single Width.....	8.00

* (Numbers) Indicate Standard Width For Module

ALL PRICES ARE:
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HAMNER ELECTRONICS CO., INC.

A Subsidiary of The Harshaw Chemical Company

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